

## BRIEFING: STRUCTURES

# Global research continues into strengthening structures against earthquakes

**Earthquakes continue to shatter buildings and the people inside them. Jose Adam and Francisco Pallarés of Universitat Politècnica de València report on recent trends in seismic strengthening of building structures.**

Every new earthquake tests the resistance of both traditional masonry buildings and more modern steel and concrete structures. However, even structures that comply with all local seismic building regulations continue to fail in earthquakes, indicating a clear need to continue modifying existing standards.

Many examples can be given of earthquakes that have given rise to multiple structural collapses with a high cost in both lives and financial terms. For example, there have been serious earthquakes in recent years in Nepal, China, the Philippines, Pakistan, Japan, New Zealand, Chile, Italy, Turkey, Afghanistan and so on.

## Three main methods

In view of the continuous risk from seismic movements, there is a growing interest in studying how to strengthen structures against their effects, and for this a number of different approaches can be used. These include

- finding elements to dissipate energy transmitted by earth movements in both new and old structures (D'Ayala and Paganoni, 2014; Khoshnoudian and Hemmati 2014)
- finding materials to increase a structure's resistance, even if it has previously been damaged (Ismail and Ingham 2014; Yaman and Canbay 2014)
- finding ways to optimise existing resistance schemes or procedures (Faella *et al.*, 2014; Ghasemi and Farshchin 2014).

The three methods are described in a special issue of *Proceedings of the ICE – Structures and Buildings*, which contains six papers contributed by 14 authors engaged in research on techniques for strengthening structures against earthquakes around the world.



Collapse of a building in Lorca, Spain during a magnitude 5.1 earthquake in 2011 – seismic design codes still need to be improved

## Present trends

The studies currently being carried out on strengthening structures against earthquakes focus on the use of modern materials, such as fibre-reinforced polymers, and more traditional concrete, steel and masonry.

In all cases of strengthening, an attempt must be made to increase the capacity of the structure to dissipate energy and improve its resistance while keeping deformation to an acceptable level, with the aim of avoiding the loss of human lives.

Present studies on concrete structures are looking into the use of composite materials to strengthen beams, columns and beam–column nodes. Other techniques being studied include concrete and steel jackets. For steel structures, the latest studies focus on the use of bracing systems and on modifying resistant sections to improve ductility and structural strength. Studies on historical masonry structures are analysing the use of mortar, compound materials and steel, with the aim of increasing structural integrity while at the same time keeping any negative effects on the building's aesthetic qualities to a minimum.

Finally, some research groups are approaching the problem by looking into the use of dampers to dissipate seismic energy and thus avoid catastrophic structural damage.

## Summary

There is a wide range of building strengthening techniques that can be used against seismic forces but the key is to use them appropriately. Significant research effort is being put into expanding knowledge on the use of these techniques, which in turn will help to save lives.

## References

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